Pet-Robot or Appliance? Care Home Residents with Dementia Respond to a Zoomorphic Floor Washing Robot

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Figure 1: Sanne, a robotic floor cleaner, and residents at a Danish care home.

ABSTRACT

Any active entity that shares space with people is interpreted as a social actor. Based on this notion, we explore how robots that integrate functional utility with a social role and character can integrate meaningfully into daily practice. Informed by interviews and observations, we designed a zoomorphic floor cleaning robot which playfully interacts with care home residents affected by dementia. A field study shows that playful interaction can facilitate the introduction of utilitarian robots in care homes, being nonthreatening and easy to make sense of. Residents previously reacted with distress to a Roomba robot, but were now amused by and played with our cartoonish cat robot or simply tolerated its presence. They showed awareness of the machine-nature of the robot, even while engaging in pretend-play. A playful approach to the design of functional robots can thus explicitly conceptualize such robots as social actors in their context of use.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in interaction design*; *Human computer interaction (HCI)*; • **Social and professional topics** → *Seniors.*

KEYWORDS

assistive robot, social robot, character design, field study, dementia, care home, toy, pretend-play, playful design

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1 INTRODUCTION

Care robotics is increasingly discussed as a way to support ageing adults and to address the crisis of elderly care. The term 'assistive robots' subsumes various types of robots which can be roughly divided into physically assistive robots and socially assistive robots [2, 45, 57]. Physically assistive robots execute utilitarian functional physical tasks, such as floor wiping, interactive wheelchairs, carrying and fetching objects, lifting people or heavy objects, relieving staff from repetitive, time-consuming or bodily straining tasks. Socially assistive robots aim at the emotional and cognitive well-being of their target group, such as interactive pet-robots like the seal-like Paro [45, 63], robot cat NeCoRo [46], Golden Pup [55], are to entertain aging individuals [55], such as the anthropomorphic robot Pepper [13]. Some social robots are intended to assist elderly people in organizing their day [8, 57], for instance with medication reminders [55].

While social robots often are zoomorphic and anthropomorphic, other assistive robots tend to have an abstract and purely functional design. The work presented here is motivated by the thought that even a 'functional' robot doing physical tasks (such as cleaning floors) without obvious social aspects and no direct interaction with humans enters the social realm. Whenever a robot shares a room with caregivers or residents, it becomes a social actor, and may be granted a social role. Thus, especially for the context of care homes, the distinction between physical and social robots is artificial and and does not accurately describe real world HRI, which is often characterized by an oscillating social status of the robot. What if we were to design functional robots to also have a social component and function?

We report on how we encountered floor-cleaning as a practical issue during our field research for the RethiCare project in a care home. This had trialed a Roomba, but residents were scared of this black, featureless, and unpredictably moving object. But floor cleaning is important for hygiene in care homes, while staff lack time for it. We thus envisioned a non-threatening, dementia-appropriate floor-cleaning robot with a secondary function of eliciting a playful and happy mood [66] in residents [70]. Our robot Sanne (short for: sanitizing robotic unit; Sanne is also a common Danish female name) is designed to resemble a cat-toy, to be perceived as amusing and as something one might interact with, but does not need to. A proof-of-concept prototype (without cleaning function) was evaluated in an exploratory study in three houses of a care home for people with dementia, involving 30 residents. Findings are based on video-recordings of the field interactions with Sanne and on conversations with staff. Our study was explorative, with an open-ended analysis, but guided by the questions of how residents react to this robot, and to being told about its function as a cleaning robot. It further aimed at determining what design features and behaviours of a playful cleaning robot can contribute to it integrating into daily life in a care home.

A previous publication [32] described the robot design without detailing its underlying design rationale and design process, and presented preliminary findings, restricted to quantitative findings. Here, besides summarizing these quantitative findings for completeness (section 5.1 and 5.2), we provide both theoretical and empirically based design considerations, and then focus on new findings from a detailed video-based interaction analysis (sections 5.3, 5.4, 5.5 and 5.6). Our contribution lies partly in describing how our design derived through a design-driven approach, based on empirical engagement with the use context. With this, we provide an example of how a robot with a mundane task functionality can integrate an additional social role and thereby foster acceptance of the robotic device. We further provide evidence that this kind of design is appropriate for the context. Elderly residents reacted positively to the robot when it was introduced as a floor-cleaner. Responding to its design as a cat-toy, residents were able to make sense of our prototype and to engage with it in a playful humorous way. Our analysis also reveals how they alternate between treating the robot as a (not very intelligent) machine and pretend-playing interaction with a cat.

In the following, we discuss related work on assistive robotics, present the design process and rationale for Sanne, detail the empirical study and findings, and conclude with a critical discussion.

2 BACKGROUND AND RELATED WORK

The appeal of robot technologies is in their ability to perform tasks with a variable degree of autonomy, using sensors to interact with the material and social world [57]. Thus, assistive robots became politically desirable tools to increase safety, quality and efficiency in hospitals or care homes [1, 22, 50]. Robots are also envisioned to support aging in place, assisting with daily life while being able to interact in a socially acceptable manner [19] as a companion robot [20, 48]. Social robots such as Pepper can engage in conversations and take the role of entertainer, fitness trainer, quizz moderator or song-circle manager [13]. But care robotics is also increasingly being discussed critically.

In elderly care, dementia is a specific issue to be taken account of. Dementia comprises a variety of brain disorders which cause deterioration in memory, thinking, behaviour and ability to perform everyday activities [35]. As example for the size of this issue, from the ca. 6 million people in Denmark, circa 85-90.000 lived with a dementia-related condition in 2021, with about 8.000 new cases every year [27]. Dementia in care homes has not received much attention yet in HCI [59]. Most such work has focused on sensory stimulation [47, 63], emotional support [63] or reminiscing [59]. A range of projects explore the use of social robots for dementia care, serving as companion, exercise trainer and personal assistant (see [17]), usually in the context of aging at home.

We first discuss critiques of care robotics, then focus on the role of anthropomorphism and zoomorphism for robotics (relevant for our design) and then motivate why robots become part of the social sphere. Research on dementia that informed our concrete work is integrated into the design discussion for our robot Sanne.

2.1 Current Critiques of Care Robotics

Current critiques of the field of care robotics discuss: impacts on human dignity [57, 61, 62, 71], development processes that frequently exclude stakeholders [57] or ignore the complex socio-material ecosystem of care practices [2, 50, 52, 57], or the tendency to over-promise on technological feasibility and just develop costly gadgets [2, 39]. Maibaum et. al. [50] discuss how care robotics has been made a political reality as attempt to 'fix' the 'health care crisis'. Most research remains technology-driven, governed by innovation bias [26, 31]. Current robotics research typically isolates decontextualized tasks [9, 50, 57], that would not work in the messy everyday routine of a care home, often "disregarding their intrinsic efficiency" and needs [50]. An example are the many proposed butler-like household assistance robots which bring a glass of water [3, 30], despite a lack of evidence for the significance of this scenario [7].

As a result, the majority of resulting devices and scenarios have only limited relevance for the lifeworlds of elderly, and the complex clinical, organisational, social and support structures and processes of care practices [2, 10, 26, 31, 52, 57]. They lack acceptability regarding functionality, behaviour and morphology, or are just too difficult to use [57]. Another point of criticism is that value-sensitive or ethical reflected approaches which center the dignity of patients [9, 23, 61] are rarely used in design of care robots [71], and that most projects follow a deficit-model of aging, focusing on potential disabilities instead of creating opportunities for meaningful interaction from the user's point of view [9, 58] and leveraging the abilities of older adults from a holistic, multifactorial perspective on aging [45].

Yet there is a category of robotic machines that are widely and reliably utilized; these perform repetitive manual tasks in logistics and cleaning, and require no or very little Human-Robot Interaction. This includes hospital transport robots, and cleaning (Roomba) or lawn-mowing robots for the domestic market.

2.2 Anthropomorphism and Zoomorphism in Robots

Sharkey and Sharkey [61, 62] discuss ethical issues due to the embodied and lifelike form of care robots (cf. [9]). Besides of deception as an ethical issue, seemingly sophisticated and human-like appearances raise expectations that current technology cannot fulfill [62], and make elderly people feel apprehensive [57]. Often, robot developers' design decisions are guided by stereotypes of anthropomorphic universal robots from Science Fiction [10], while the same Sci-Fi imagery influences laypeople's interpretation of robots [72], resulting in high expectations and a disappointing interaction experience. Recently, Darling [18] argued to instead think about robots in analogy to our relation to animals and pets. Empirical research on whether non-lifelike robotic pets or dolls for the elderly are ethically problematic is inconclusive. Elderly people who saw videos of companion robots (e.g. [16]) voiced concerns over loosing autonomy and found these condescending or patronising (either too toy-like or inauthentic if pretending to be a living animal), even if users may knowingly give in to the fiction of interacting with a (machine) companion. Other studies [44] report less concern from elderly people about engaging in this sort of make-believe interaction, arguing that the relationship could resemble that with a plush toy. What might explain these opposing reactions (in [16, 44]) is that people often behave different than they expect themselves to, and aim to self-portray themselves as rational adults, which may influence interview responses to such stimuli.

Given we decided to make our robot Sanne cat-like, this was a point for deliberation. A main factor for us was that for people with dementia, interaction with toy-like objects has been shown to have benefits for emotional well-being, demonstrated by studies of robotic teddybears [55], Paro [15, 61], and the realistic NeCoRo cat which emulates the behaviour of a cat when touched and stroked [46]. In our care home partner, dedicated dementia dolls had proven useful as emotional support and calming influence. We find inspiration from Lazar et al's findings [44] that robotic pets can also provide 'social entertainment' and create opportunities for social encounters, for instance by serving as 'ticket to talk'.

2.3 Even Task-Focused Robots are Part of the Social Sphere

A common distinction for care robots [2, 45, 57] is between (1) effective or utilitarian, physical assistive robots and (2) affective or social assistive robots, which are often framed as companions. Many companion robots (especially for ageing-in-place) already combine task-based services (e.g. fetching things, fall detection, reminders) with social robotics features and companionship (e.g. the rather abstract butler-robot Care-O-Bot [29], or the more anthropomorphic Hobbit [25]). But physically assistive robots designed to help aging people or to support care staff tend to be discussed and designed from a largely functional perspective, neglecting potential social aspects inherent in such tasks and the larger social context. We argue that even for robots with a dominant functional task, it can be beneficial to explicitly design for a social role. This is because any robot sharing physical space with people will be likely to be perceived as a social actor, and treated as such, becoming part of the social sphere. Our perspective is informed by empirical research on robots, and by sociological concepts and theory, regarding how people interpret technologies as social actors and also react to them based on social scripts [56].

2.3.1 Material Tools (and Machines) as Social Actors. Vacuuming robots are well researched and even though these are fairly 'stupid' machines for a manual task, studies have identified social elements in how they become integrated into households. People enjoy personalizing their Roomba robot [69], it influences the social practices of housekeeping, is given names, cleaning becomes a social activity [28], and people talk to Roomba robots as if it was a pet or teddy-bear.

Various HRI studies observed how humans interpret robot behavior, ascribing agency and intentionality even to simple robots, thereby granting the robot a proto-social status. Especially errors and mistakes that violate common social behavioral rules invite such interpretation as e.g. 'queue jumping' [10] or 'cheating' [64]. Yang et al [74] found that people develop a mental model of a robotic moving trash bin 'as having intentions and desires', waving trash to attract the robot, and whistling at it like at a dog. Here, people interpret robot behavior as a social cue, and then react with familiar social interaction patterns (see [56]). In another study [51], a group of care home residents argued they wanted a robot that "looks just like a machine". However, during tests they then walked aside the prototype, engaging in small talk with the robot. Darling [18] describes how soldiers became emotionally attached to bomb disposal robots. Thus, even functional robots are interpreted as social actors.

Our work is furthermore inspired by Actor-Network-Theory [42]. Latour argues that artefacts participate in human practice as "mediators" of meaning, as they can translate and distort the meaning they are supposed to carry [42]. Thus the introduction of artefacts in a practice will lead to unpredictable outcomes in ongoing practice. When a personal computer breaks or new features are available, it requires strategic adjustments from human actors. Artefacts with their affordances and sensorial qualities can suggest possible courses of actions, communicate values, and elicit emotions, especially when employed in social interaction and practices [4, 53]; in Latour's terms, artefacts as mediators are regarded as social actors in practice, at the same level as humans [42]. Barad coined the term "intra-action" to define the intertwined nature of the interaction between humans and their artefacts as: "the mutual constitution of entangled agencies" among the different actors participating in a shared practice (human and non-human alike) [4], where the agencies of different actors emerge or are molded and transformed [4]. Through such entanglement, robots might trigger emotional and social responses in users, which were not planned or predicted by their designers.

These perspectives [4, 42] help provide an understanding of how robots designed for a practical function trigger emotional responses and elicit changes in the social dimension of practice, in behavior and experience of users, as exemplified by studies of the Roomba. Moreover, according to Barad's intra-action perspective, any robot sharing the same space with people and participating in human practice becomes a social actor, as exemplified by HRI studies [64, 74]. Therefore, design should intentionally address social roles for a robot, no matter how practical or trivial its function might be.

3 DEVELOPMENT AND DESIGN CONSIDERATIONS

Assistive robots for healthcare deal with a complex context, involving a diverse group of individuals, who would be affected by technologies in different ways [49, 57]. A robotic floor cleaner affects care home staff as primary beneficiaries, as they would otherwise be in charge of cleaning. Since hygiene is an important factor in the well-being of residents, a robotic floor cleaner will also affect them indirectly. Moreover, since such a robot will often share spaces with residents in everyday encounters, its design will directly affect the residents, which means they are also primary stakeholders.

This research is part of the RethiCare [1], an interdisciplinary research project aimed at challenging and re-shaping visions, research and design practices of assistive robots for care homes, adequately addressing the needs of aging adults, in many cases affected by dementia, and staff. The project is funded by VolkswagenStiftung. As part of RethiCare, informed by ethnographic observation and literature on care, a range of concepts for robots for the care home context were developed in an interdisciplinary design-led ideation process. Sanne is one of the resulting design concepts, and in the following, we focus on Sanne.

Our main partner for this study was OK-Fonden[2], a non-profit care organisation managing 16 care homes in Denmark, a number of housing communities, a hospice as well as psychiatric residential and treatment centers. The research for Sanne followed a human-centred design methodology, working in close contact with two OK-Fonden care homes located in Odense, Denmark. The proportion of residents with severe forms of dementia is very high in Danish care homes. Denmark has an extensive system in place for aging at home, therefore elderly people are transferred at a much later stage into care homes than in many other European countries. All care homes residents thus require care related to their specific stage of dementia, including reminders and simulation to eat and drink, preventing them from leaving the building, cognitive training, support of emotional well-being, and social activities. As a result, the caregiver staff is under constant pressure of compensating for the cognitive difficulties caused by dementia, beside the 'normal' tasks of physical and medical care.

Our research began with an extended phase of observation and in-situ interviews, followed by design conceptualization, where we shared our ideas first in form of sketches with the head of the care home, then in 3-4 iterations of an animated video scenario which were also discussed with the head. Based on this dialogue, a high-fidelity proof-of-concept prototype was created, which was tested in two care homes with staff and residents. Because most residents are affected by different degrees of dementia, we were not able to (not allowed to) involve residents on a regular basis in participant observations or any co-design activities. Moreover, during our design phase, national lockdown policies related to the Covid-19 pandemic made it impossible to keep direct contact with caregivers and residents. Thus, we had to rely on the perspective of some staff and of experts in geriatrics (i.e. design by proxy [65]). We kept regular contact with the head of our partner care organisation, who also participates in caring duties, and talked with various staff regarding their needs as well as needs of residents. However, by the time we conducted our study, lockdown policies in Denmark became less restrictive. As a result, we were allowed to visit the care homes in small groups of two to three researchers and could conduct three testing sessions in-situ.

3.1 Understanding the Context and Seeking Inspiration

We first conducted an ethnographic-style study focused on the daily activities in two care homes, both located in Odense and managed by OK-Fonden. Care home A consists of several house units (buildings) with 9 residents per unit, and care home B is a two-floor building with in total 26 residents. One of the author-researchers conducted observations and situated interviews, shadowing staff and residents during daily activities, usually for half a day during the mornings for about 2-3 days a week over a period of 2 months, totaling to 20 half days (ca. 80 hours). Observations were mostly during mornings since, in the afternoon, most residents are tired and take a nap

[1] http://www.rethicare.info//

[2] https://ok-fonden.dk/

or engage in personal relaxation activities. Observations focused on the social interaction between staff and residents during daily activities and the use of available technologies.

During mornings, residents were offered social activities and games to train memory and fine movement, beverages, as well as new technologies were tried out, such as interactive exercise bikes. Visits from a 'clinical clown' occurred either then or after lunch. In general care givers attempt to relieve residents from monotony, keeping them physically and psychologically active. During activities, the researcher observed and chatted with residents about the activities and technologies used. Whenever possible, she joined the residents in activities. Because of ethical and legal reasons, data gathering was mostly limited to note taking and drawing [14], but photos where allowed if focused on staff or artefacts. To record a situation, quick sketches were made of people participating in activities and the context.

3.1.1 Floor Cleaning as a Pragmatic Problem. During interviews, staff argued that floor cleaning is one of the most time-consuming and challenging tasks, yet vital for hygiene, where robot technology could make a real difference for them and the residents. They told of prior attempts to use Roomba robots. These were purchased by the municipality in 2016 and used for ca. 3 months to clean floors in the care home's common rooms. Within one month, care staff put in 15 warning reports on residents being at unease and scared by the robot. Severe behavioral changes were noted (residents became silent and behaved worried in the common areas, smiled less, some even refused to leave their own room). One reason residents were scared appeared to be that they could not properly see the Roomba moving across the floor, and had difficulties predicting its movement and direction, due to its dark colour and minimalist round shape. One of the staff argued that: *"The residents saw a dark hole moving across the floor, I would be scared myself if I saw a hole moving across the floor!"*. Moreover, the noise level appeared to disturb residents. Extended exposure did not improve reactions, as residents did not grow familiar. Staff always explained the Roomba as vacuum cleaner, but residents had forgotten about this the next day, needing a new explanation, which they again forgot. Eventually, it was decided to only use Roombas in areas where residents do not encounter them, e.g. after opening hours in day care centers.

Nevertheless, given the Roomba has been shown to be a useful household tool [28, 69] and blending well into family lives, we saw this as a missed opportunity. The starting point for our work thus was to address the need for a floor cleaning robot while serving the needs of residents affected by dementia and explicitly designing a social role for the robot. In the terms of Latour and Barad [4, 42], no matter how practical, any daily activities at the care homes and the artifacts involved are loaded with social and emotional values.

3.1.2 Daily activities as Social-Emotional Activities - A Playful Mood . Observation revealed how staff continually aim at making residents feel safe and taken care of. Every activity was characterized by an empathetic tone and playful mood. Staff attempt to establish eye contact and smile at residents; they carefully articulate without raising their voice, not to sound aggressive or harsh. This is because most residents wear hearing aids and might have hearing difficulties.

Figure 2: The Clown demonstrating typical situations with elderly people (photos with permission)

Staff reported to try out available technologies to make daily practices easier, more stimulating or fun. Technology was sometimes appropriated to guide residents for other activities. For instance, music or interactive projections from a projector mounted over the dining table were utilized to attract residents to the lunch table or to make them start play games. Staff often picked red plates as these seem to attract attention and stimulate residents' appetite. Overall, care activities often were presented and 'packaged' in a playful or narrative way. For instance, when reminding to drink or eat, this was framed as a party with friends, serving drinks on a tray, inviting residents to drink by saying "Cheers!", and sharing a drink with them. This playful attitude greatly inspired our design.

During observations of a 'clinical clown' this playful aspect of care practice became clearly evident. Professional clinical clowns, while not having a functional role, are important contributors to care practices and residents' well-being in Denmark.[3] The clown cooperates with the care home to investigate the impact of positive psychology on the well-being of residents. Her function is mainly to entertain, activate, and engage socially with residents residents, using the role model of a clown. The clinical clown demonstrated and shared her knowledge on how the residents like to be encountered in their physical space, without feeling threatened or scared. Through this, the clown provided inspiration for both the patterns of movement and the appearance of Sanne in terms of practice-based knowledge of 'what works well for people with severe dementia'.

The clown has developed a pattern of carefully approaching residents that makes them feel safe (see fig. 3). This involves: establishing eye contact with the targeted resident, clearly signalling

[3] In Denmark, clinical clowns are professional practitioners from an internationally recognized 1.5 year training program. Their training includes acting and mime performance, neuro-psychology, interpersonal relations, cooperation with clinical staff. Their role is to contribute to physical and psychological well-being of care home residents, and support them in dealing with dementia and other conditions. They physically and socially engage with residents through performance and personal dialogue, creative activities, walks and chats. Source: danskehospitalsklovne.dk/om-danske-hospitalsklovne

Figure 3: The Clown approaches a resident, swaying gently back and forth to be noticed, so the resident is prepared for her approach, before bending down and touching the person.

changes of direction by turning her torso and head in this direction, walking at a slow pace, swinging gently back and forth, slowing down and bending her torso when approaching an individual. As she approaches a sitting resident, she gets down at eye level, kneeling down. This movement pattern enables people affected by cognitive impairments to predict her next move. As she speaks to residents, she smiles and whispers, using a calm tone to get their attention. Moreover, the clown is dressed as a cow, wearing a bulky, furry costume with black and white spots, which makes her look amusing, nonthreatening, and easily recognisable (see fig. 2). Her appearance attracts attention and laughs from the residents. The costume makes her quickly noticed as she enters the room, so that residents already look at her, following her movements and preparing for a potential interaction. It further frames her in the familiar role of a clown, funny and non-intimidating.

3.1.3 Toy-Like Products for Amusing and Calming Residents . Similarly to the design process for Paro [15], we looked at current artefacts and practices used to support residents' well-being. We saw a series of toys used, which according to staff enable the residents to amuse themselves alone or in small groups, to relax or calm down if they are restless (fig. 4). 'Store Bent' is a large size, soft and heavy stuffed sloth with a round face and big round eyes. The staff explained that its softness and weight calms down residents. This calming effect was also described for Flora, a sensory stimulation weight blanket shaped as a huge hippopotamus face, with large round eyes and round white nostrils. It was common to find residents relaxing or sleeping on armchairs, holding either of these. The staff also mentioned the Ruben's Dolls[4] as popular, anthropomorphic dolls from soft fabrics, like tiny toddlers, with a round face, large round eyes, and a small smiling stitched mouth. All these toys come in calming, neutral colors.

3.1.4 Summary of Inspiration for the Design of Sanne. Beside of the cleaning task as a functional need, the playful mood observed in the interactions of staff with residents and the use of toys in the homes inspire our design concept. Moreover, while our robot design does not emulate 'normal' human interaction patterns, we aim to emulate core aspects of the Clown's interactions with residents, that are specifically designed for this target group, taking account of their cognitive and emotional state. We further took inspiration from the stuffed toy's visual designs.

3.2 Design Considerations for Sanne and Iteration of the Design

The design process went in three iterations from the initial idea of a robotic appliance that could be fun and socially engaging to the proof-of-concept prototype. After first digital sketches, use scenarios were created, including a short video of animated sketches that also showed potential challenges anticipated by the research team. Interviews with management and staff members of the care homes, the board of OK-Fonden, provided feedback to the researchers' idea as well as additional insight into residents' and stakeholders' needs. In response to these conversations, the initial idea for a tortoise character was replaced with a cat (more familiar to residents), and design details were adjusted. We now explain this process in more detail.

Research has documented the positive effects of laughter and humour on people with dementia [70]. Given residents tend to perceive zoomorphic forms or characters as amusing, we decided on a playful, zoomorphic look for our prototype, to elicit positive emotion and laughter. This avoids anthropomorphic forms [18], and signals that the robot has only limited intelligence, interaction capabilities and/or decision-making abilities. Based on [51], we further expected that the residents would perceive a robot that resembles a pet-like toy as less threatening than an anthropomorphic robot. The design was also inspired by the clinical clown, her outfit and way of moving, and the toys popular with residents, taking up aspects of their aesthetics and shapes. While Sanne could be considered a pet robot (like Paro or NeCoRo), the design aims to avoid life-likeness, so as not to deceive about her machine-like nature (to avoid the ethical issues of life-like zoomorph robots, cp. [16, 44, 61, 62]). Based on these considerations, we elaborated first sketches. The first concept was designed as a light-coloured turquoise tortoise, a round slow animal, signaling that it will move slowly. Similar to the toys in use, this used calming neutral colors. With a toy-like appearance, we aimed to invite playful interactions and role-play, as when residents play with Store Bent as if it was a dog or cat to hug and cuddle.

First sketches showing Sanne in envisioned situations (see fig. 5, left) were presented to the head manager of the care home as our

[4]https://rubensbarn.com/?v=f003c44deab6

Figure 4: Left: The stuffed sloth Store Bent (https://oliz.dk/en/produkt/health-care-dementia/), and a resident taking a nap hugging it. Right: Flora, a stuffed blanket shaped as a hippo head (https://oliz.dk/en/produkt/sensory-stimulating-weight-blanket-flora-small/)

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main contact. She liked the idea of a robotic tortoise, but recommended using a common pet, such as a cat or dog. They care home had unsuccessfully trialed Paro, but the residents found it confusing: *"They did not know how to interact with it, it is not common in Denmark to have seals as pets!"* They tried to pet Paro, but acted as if scared or confused and later simply ignored it. Research on dementia [11, 33], recommends that the design of technologies and artefacts for dementia patients should take into account perceptual familiarity and align with their previous experiences. We settled on a cat, a familiar pet often associated with positive experiences; also cats have independent behaviour patterns and people know that cats sometimes want to be left on their own and do 'their thing', but can be petted and interacted with if they are in the mood. We thus hoped the residents would be willing to play and pet our cat robot, but also to understand that it should be left alone when washing the floor.

Regarding the color, the head manager argued that *"for a mobile robot a red or orange color could be more effective"*, since *"green is too easy to ignore, red is an 'action color', an attention color"*. White and black would be too difficult to perceive. Colours do influence the residents cognitively and emotionally, with red and orange being stimulating due to their vibrant chroma [21, 24]. Thus, Sanne was colored red and orange (fig. 5), which would not only ensure that she is perceived as friendly and stimulating, but also be easily seen and reduce trip hazard. In the original sketches, we provided Sanne with a small tail (fig. 5), intended to signal changes of direction. However, the tail was not implemented as there was concern that residents might trip over the tail when passing by.

Because the floor is considered potentially unhygienic, the body of the robot (especially its head which might get touched by residents) needs to be at 20-30 cm height, well above the ground. This also makes the robot more easily seen. But as it needs to be able to drive under furniture for cleaning, its height is limited. As for the material, Sanne was designed as a plastic toy, without fur, to avoid the interpretation that Sanne was actually a cat, but also for hygienic reasons, as fur can attract and spread dust.

For the detailed design, we applied principles from character design methodology [40, 41, 60, 68, 73] to Sanne's appearance. Characters are the "cast actors" [60] of a story, in charge of enacting the story and making it alive. Sanne should have a distinct personality [41], to elicit emotional responses and invite residents for pretend play or to relate to the character as a mascot. Furthermore, if Sanne provides social cues, then this could activate familiar social scripts in the residents (cp. [56]). This approach enabled us to rethink the design of our robot as if it were a character within a storyline [41, 60], set within the world of the care home which includes the residents and caregivers. The design aims at communicating what Sanne can do, how people might relate to her and what her capability are, and focuses on factors such as (cf. [60, 68, 73]): appearance, visual style, voice, goals, the characters' actions. Multiple digital sketches were then combined in video scenarios, showing how Sanne might interact with residents and staff in the care home.

Shape and proportions tell a lot about the personality of a character [73]. Inspired by the toys seen at the care homes, Sanne was from the start thought as a short character with a round body, to appear nonthreatening and fun, like the chubby characters in games and cartoons. Based on feedback from staff, Sanne was given a round-oval head, large round eyes and a a sketched mouth, suggesting a smile (inspired by Store Bent). Such facial features express positive feelings that elderly people with dementia (who have difficulties reading emotional states) won't mistake as threatening. This look aims to communicate a storyworld in which Sanne is a friendly and helpful robot-cat living in the care home, that people can play with if they want, as with a toy. Interestingly, staff advised to give Sanne a "static face", avoiding dynamic facial expressions (such as a screen or blinking eyes), which residents might find hard to process. This advice was particularly interesting as such dynamic features are commonly described as important for social robots [5, 36, 75].

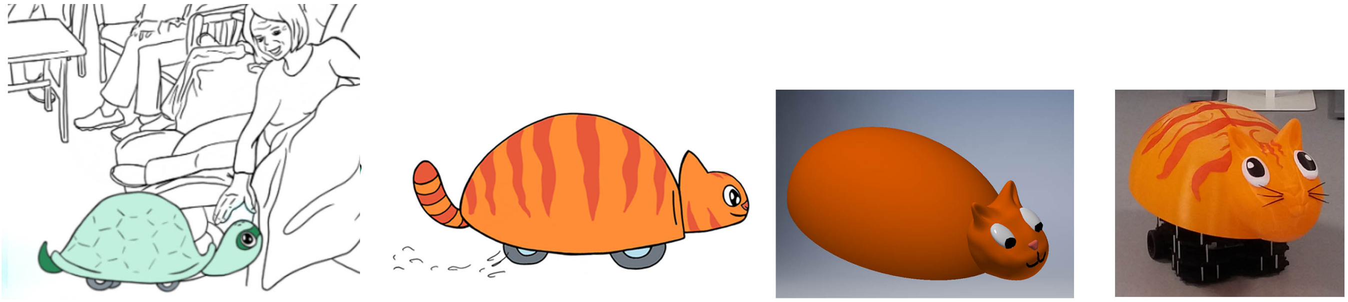

Figure 5: Design iterations for Sanne, from first sketches, first as a green tortoise (shown in a scenario), then the revised design as an orange cat, over a 3-D model, to the proof-of-concept prototype developed for our study.

For the proof-of concept prototype, the 3D-printed body of Sanne (hand painted) was mounted on a TurtleBot [5], a modular robotic unit widely used in teaching and research, due to its small size and flexible design. This prototype weighs around 4 kg, is 80cm long from head to tail, 40cm wide and around 40cm high, so it can move under furniture.

4 STUDY APPROACH

The user study was conducted at the mentioned two Odense care homes managed by OK-Fonden. The study approach and process had been approved by the organisation's management, and informed consent was provided by the residents' legal representatives for them to take part, including video recording of the study for research purposes.[6]

The organisation took care of distributing forms for us, so that age and names of residents were not recorded on our side. To safeguard participants' privacy, they are anonymized here through adapted drawings based on recorded videos (these retain body poses and facial expressions, but change clothing and appearance). After the trial sessions, we talked with care home staff and with management staff about how they experienced the study and asked for background on some situations and residents, in order to help us interpret their behavior.

The study was conducted in 6 house units of the two care homes mentioned earlier. A unit consists of the individual resident's personal rooms as well as shared spaces (lounge, dining area). We visited units across three days, with varying length of trialing Sanne in one setting (e.g. the shared lounge room), sometimes repeating a visit to a shared space with the aim of getting further inhabitants of the unit involved. Each individual visit lasted between 7 to 20 minutes depending on the inhabitants' engagement with the robot. The study time in total amounted to 2:07h.

This was a field study in the natural, everyday setting of the care homes. This means that those residents, who happened to be in the shared rooms where we tested Sanne on these occasions and that we steered Sanne towards (or that reacted to Sanne before the robot actively approached them), thereby participated in the trials. We had Sanne approach most residents present in the room, who thus are all considered 'participants' independent of whether they reacted to Sanne or not. We visited home B unit 1 twice on one day over the course of the morning, and again around lunchtime on the following day (a total of 7 people, of whom one encountered Sanne twice and another three times). Unit 2 of home B was visited on two successive days in the mornings. Here there were 6 participants, of whom 3 encountered Sanne twice. We visited Home A once, going into four different units of Home A (with 4, respectively 5, study participants at each unit) between 11 (before lunch) and 12:20 (during lunch).

Overall, 30 residents participated (16 female, 14 male). The majority of residents are affected by serious dementia (or have cognitive impairments that result in similar impairments), at level 6-7 according to the Reisberg scale (https://alzheimersdisease.net/reisbergs-stages), thus at 'severe / very severe cognitive decline', where level 6 and 7 correspond to a mental stage of 2-5 years, respectively 0-2 years of age.

A team of two to three researchers was on-site for this study, with one person responsible for managing the technology, and the other one or two observing and taking notes. One or two staff members were continually present to assist in communicating with residents, usually leading the conversation and - if needed - to intervene. In order to blend in, the researchers wore a care staff uniform. As the study took place under Covid-19 pandemic restrictions, the researchers took a Covid test for each day, wore a face shield and kept distance from the residents.

One researcher controlled the robot in Wizard-of-Oz fashion [43, 74] via remote control, to provide the impression that the robot moves autonomously, while being able to react and improvise according to the situation. Especially given the uncertainty of how residents would react, it was important to be able to quickly adapt the robot's behaviour, instead of relying on pre-programmed routines. This researcher stayed in the background and hid the remote

[5] https://www.robotis.us/turtlebot-3-waffle-pi/

[6] There is only optional, no mandatory IRB process for user studies at the authors' institution and country, and the process is entirely volunteer-based. Authors took care to adhere to ethics guidelines for dealing with human subjects (e.g. https://www.acm.org/code-of-ethics, British Sociological Association Statement of Ethical Practice), in particular regarding consent (given the legal status of residents via legal guardians), avoiding harm, and ensuring privacy. Having staff present closeby throughout and remote-controlling the robot minimized risks to participants' well-being. Close or physical contact was only initiated by residents, never by the robot. Moreover, the general study procedure was discussed with and approved by the University's legal department, regarding all matters regarding personality rights and privacy (GDPR); this reviewed and approved the process of obtaining consent and consent forms, as well as the use of comic-style depictions based on video stills as used in this submission (as we are not permitted to use images that could identify individual participants).

Figure 6: Sketch from the room-camera, showing a researcher taking notes on the left, and on the right a seated resident bends down to pet Sanne

control from sight (standing in the door on the left in fig. 1). Another researcher remained close to residents, to note down their reactions and utterances (standing on the far right in fig. 1, behind residents, sitting on the left in fig. 6). Care staff were sitting or standing next to the residents, as in their usual practices, talking to them or supporting their daily activities.

For later analysis, the trials were video-recorded. One camera was mounted on the robot's head, approximating Sanne's field of view, to record close-ups of interactions. A second camera was installed in the room, to record the overall area and any interactions between residents and what role Sanne might play for these (this camera unfortunately did not work on the second day). We could collect in total 2:07h (head-camera) and 1:37h (room camera) video.

To investigate whether residents' activity levels impact on their reactions, trial times were distributed before and during lunch, since during lunch, residents are busy eating, whereas before lunch they often sit together or alone in the common areas. This was of interest for two reasons: to determine whether the robot might distract too much from ongoing (potentially important) activities (such as eating); and to help identify situations where the robot is ignored, which thus might be suited for its cleaning duties.

Three movement patterns were available for Sanne that were utilized where they seemed appropriate. 'Fast' was the highest speed the robot can reach, generating louder noise. We deployed this only three times to see whether the noise makes residents shift their attention to the robot, given staff had told us that some residents react very sensitive to unknown and incomprehensible noises. This pattern was used only if Sanne had to travel a long distance while residents were several meters away. 'Normal movement' was used whenever residents were close to Sanne, but no approach was planned. The robot then drove at regular speed, at medium noise level not surpassing environmental noise in the room (kitchen sounds, music, people talking). The 'wiggling movement' was used to approach residents, inspired by the movement of the clinical clown. Sanne slowed down, stopping at about 1.5 meter distance before residents, and moved slowly back and forth as well as sideways, reminding of a wiggling pet animal (fig. 7). Wiggling was used to get resident's attention. Frequently, we controlled Sanne to move at the normal speed until a resident was close (ca. 1,5-meter distance). Sanne then was made to sit in place and to wiggle until the resident shifted their attention towards her. Then, we had Sanne move 'normal' again, until close enough for the resident to interact. She then waited, using the 'wiggle movement', until the interaction was ended by the resident or interrupted by an outside event. If the resident did not pay attention to Sanne, she would drive away in her normal movement.

5 OBSERVATIONS AND FINDINGS FROM THE IN-SITU STUDY

The video data was analysed in several iterations by three researchers. First, it was documented in a logbook for an overview of the data. Then, the team watched and discussed sequences of interactions between Sanne and residents, familiarizing themselves with the data in an open approach, as recommended for video analysis and thematic analysis [12, 34]. A sample of 37 scenes involving 30 residents was selected, showing interactions, conversations, and situations of Sanne being ignored when Sanne is closeby. Emerging themes from this initial phase were noted for more detailed investigation.

As a first analysis step, a systematic coding approach was applied, categorizing sequences according to residents' reaction of acceptance or rejection of Sanne in their space and the activity level of the situation. In a next step, following typical procedure in video interaction analysis, rich sequences were identified for transcription and further analysis. 22 sequences were transcribed into

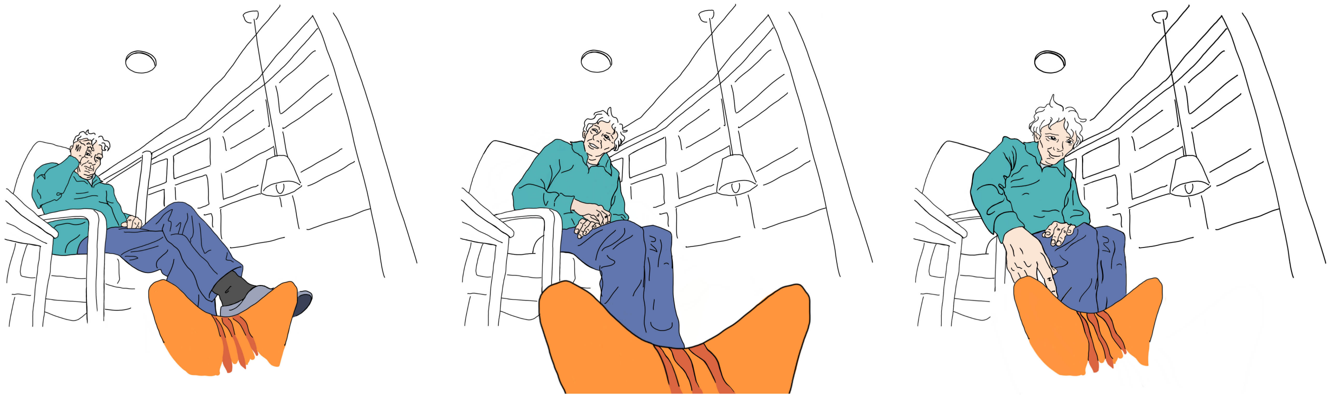

Figure 7: Sanne wiggles back and forth to get a resident's attention (drawn from video from the camera on Sanne's back)

text and translated from Danish into English. The team then jointly selected several of these for a further detailed analysis, oriented by principles of interaction and video analysis [34, 37], focusing on both verbal and non-verbal expression. Video interaction analysis focuses on sequential analysis of observable actions, through which meaning is interactively established. With each turn, interactors express meaning and ascribe meaning to the action of the other. Insights were then clustered into themes, as presented in this paper.

We first summarize the type of reaction to Sanne (categorized as positive, neutral, non, negative) and how they became aware of the robot (previously described in more detail by Grimme et al.[32]), and then summarize the influence of current activity level (cp. [32]). We then move to detailed observations of how residents reacted to Sanne and how they interacted with her. In particular, we found that residents readily accepted the notion that Sanne is a cleaning robot when introduced as having this task, and were more sceptical if she was introduced as a cat. Sanne was clearly identified as machine-like, while residents nevertheless engaged in playful interaction with her cat-character. They did not appear confused about this dual nature of technical machine and cat-toy. The robot served as talking point and occasion for jokes, contributing to the playful mood supported by staff. Moreover, we could observe how the relationship to Sanne evolved over multiple encounters, building up familiarity.

5.1 General Reactions - Mostly Positive or Neutral

First, we reviewed the video data to determine whether residents had any negative reactions to Sanne, as this is central to assess the general appropriateness of our concept for a playful cleaning robot. We categorized reactions as positive, neutral, or negative, and non-reactions. Of 37 recorded situations, 16 were coded as 'positive' reactions; residents commented positively on, lured, touched, or laughed/smiled at Sanne. 'Neutral' reactions are where residents noticed Sanne and did not display disagreement about her presence, but did not follow up on interaction with her or dialogue with others about her. For instance, they observed Sanne without any positive or negative reaction, or just listened to a caregiver talking about her. This occurred 11 times. We only saw one negative reaction, when a resident kicked the robot (we were later told that this resident hates animals). The non-reaction category, observed 9 times, covers situations when residents were either unable to notice Sanne (her out of sight, the resident busy e.g. eating) or appeared to ignore her. Table 1 lists all reaction types in more detail. For a more detailed description, see [32]. We thus find that Sanne was not a disturbance, and that most explicit reactions were of a positive nature. We consider cases of no reaction as a confirmation of our design, as residents did not react scared or annoyed, but simply went on with their activities.

We briefly discuss the positive reactions after residents shifted their attention to the robot. Some talked about Sanne, making positive comments (*"Oh it's really cute."*) or asking questions to a staff member. Other residents talked directly to Sanne. Ten residents attempted to lure Sanne closer as one would do with a real cat, by whistling, clicking their tongue, or by reaching out with one hand, rubbing middle and index finger against the thumb or opening and closing their hand in a luring gesture (see fig. 9). Five residents touched Sanne after luring and/or talking to her. More detailed video analysis revealed patterns in the interaction. After petting Sanne first, all shifted to scratching, knocking between the ears or even attempted to lift the robot off the ground by grabbing its ears or head. Most also scratched Sanne's head with their fingernails or touched the camera, in order to check out the material. We return to some of these interactions later, when we discuss how Sanne was treated both in make-believe interaction as a cat and as a machine.

5.2 Factors Influencing How Residents Became Aware of Sanne

We also analysed the video data with regard to how residents became aware of Sanne. Attention was raised by either movement, noise, through a staff member or another resident. From the 37 situations in table 1, only four residents were unable to see the robot (e.g. they were half-asleep or Sanne was out of their field of view). Movement predominantly (23 times) raised attention, in particular the 'wiggling' (fig. 7) succeeded to gain attention. Three residents noticed Sanne when driving at high speed, thus higher noise level, and all looked at it when the robot accelerated. Seven

Reaction	Situations	Sub-type	Situations
Positive	16	Talking about	4
		Talking about and luring	2
		Talking to	1
		Talking to and luring	2
		Talking to Sanne and touching	1
		Talking, luring and touching	3
		Luring Sanne (no talk)	2
		Luring and touching Sanne	1
Neutral	11	Observing Sanne	6
		Listening and agreeing	4
		Listening	1
Negative	1	Kicking	1
Non	9	Not interested /ignoring	5
		unable to notice Sanne	4

Table 1: Different types of reactions to Sanne, differentiated into sub-types, and number of occurances

times, residents' attention was drawn to the robot because a staff member pointed it out and talked about Sanne. Sanne thus was quite successful in attracting attention; in comparison, tests of Paro in a care home [15] found that it was often ignored and interaction usually was preceded by staff or visitor mediation and encouragement. Three residents then tried to introduce Sanne to another person. One walked over to a woman in a wheelchair, who has difficulty seeing things on the floor and tried (unsuccessfully) to make her aware of Sanne. In vignette 4 (see section 5.3) a resident explains Sanne's purpose to another resident. Another resident, after following staff's suggestion to stand up (during lunch) to see Sanne, then asks her neighbour: *"Have you seen it?"*

We found that the activity level strongly influenced residents' reactions (see fig. 8) (cp.[32]). Sitting or standing around was categorised as a *low activity level* whereas situations where no intense focus is needed, such as reading magazines, watching TV, having a snack, drinking, or walking around, were categorised as *middle activity level*. Being busy in conversation, focused activities such as handicraft or having a meal were labeled as *high activity level*. 19 situations could be categorized as low activity level, 9 as middle level, and another 9 as high activity. Most positive reactions towards Sanne occurred at low activity levels (11 from 16), and only one at high activity levels, whereas 6 of 11 neutral reactions occurred at high activity levels. Non-reactions to Sanne were balanced over all levels.

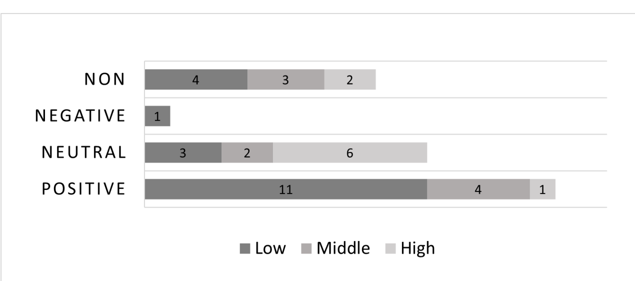

Figure 8: Activity levels (low, middle, high) and reaction type

These observations indicate that the 'wiggling' movement is effective to attract attention. Wiggling can be seen as a polite way for Sanne to move towards people, giving them time to see her and decide if they want to play with her or not. That Sanne tends to get ignored during high activity levels indicates first that the robot is not too distracting (does not disturb e.g. during meal time) and that these would be ideal times for 'cleaning duties'. High speed movement should predominantly be used when the robot is far away from people and when existing noise levels can 'mask' the resulting sound.

5.3 Accepting Sanne Being Introduced as a Cleaning Robot

The staff often introduced Sanne to residents. Sometimes Sanne was described as 'helping with cleaning' and at other times, staff introduced her as 'a cat'. In total, Sanne was introduced 7 times as a floor cleaner/washer, 6 times as a cat and in 5 situations she was neutrally referred to as 'it'. We here analyse how residents reacted to either introduction, which ascribes a different role or function to the robot, in particular, whether they object and/or question it, or whether they accept the introduction and thereby the ascribed role.

When Sanne was introduced as 'will be cleaning', residents reacted positively and interested, whereas if she was introduced as a cat, they were far more critical and sceptical. In the latter case, two residents did not react, one person continued with the previous conversation, and two residents instead responded with questions about the technical functionality (see vignette 1). Here, by asking if Sanne is walking on wheels, the resident indicates she is aware it is something mechanical. Once the employee explains that Sanne should clean the floors, she reacts with pleasure and curiosity.

> Vignette 1: Two resident sit at a table, a staff member stands next. Sanne approaches, stops and wiggles.
> Staff: *"Look, the cat is coming there."*
> (Resident A bends over and sees Sanne. She has a

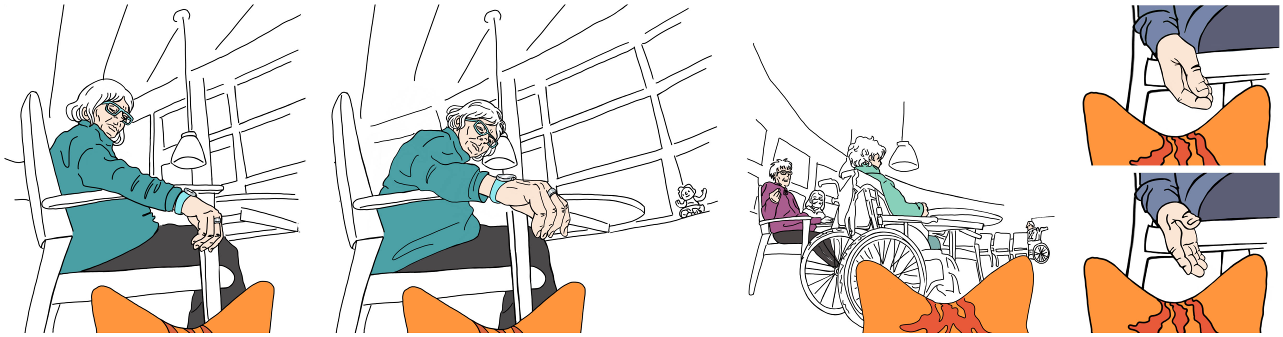

Figure 9: Sanne being lured - (left and left-middle): Woman in green luring her closer by rubbing fingers, (middle right): Woman in purple luring her from afar, (right): closeup of waving-luring gesture

questioning look on her face.)
Resident A: *"Is it walking on wheels?"*
Staff: *"Yes it does. But it's very cute, isn't it?"* (They both laugh.)
Staff: *"If it's supposed to wash our floors wouldn't that be ok?"*
Resident A: *"Yes, of course!"* Staff: *"It can't do that yet."*
Resident A: *" How is it going to do that?"*

In the next vignette 2, Resident B meets Sanne again, after seeing her the day before. She is still at an early stage of dementia and has good memory. She interacted positively with the robot on the first day, lured it and asked what it is doing on the floor. On this first day, nobody had introduced Sanne to her, and she showed interest and curiosity. In contrast, on the second day, when the robot is introduced as a cat, she now clearly objects to this statement.

Vignette 2: Residents have lunch together. A staff member stands next to them and introduces Sanne as a cat.
Resident B responds: *"I saw her 17 times yesterday, that's nothing new. It doesn't look natural, it's a fake cat"*.
She says this in an annoyed and disapproving way, and exaggerates (on seeing her 17 times).

Having Sanne introduced as 'cat' raises resistance, as residents appear aware that this is a machine, a *"fake cat"*. In contrast and despite the cat design, residents readily and in a matter-of-fact style accepted the robot's introduction as a cleaning device. When Sanne was introduced as a cleaning robot, three residents reacted with curious questions, another three simply accepted the statement (did not object) and one person continued conversation with staff. In vignette 3, four residents sit in chairs, watching TV, aside staff (note: resident C asking more technical questions is still at an early stage of dementia). A staff member introduces Sanne as a cleaning device.

Vignette 3: Sanne enters the room and approaches resident C.
Staff: *"It's supposed to wash the floor."*
Resident C: *"OK it's going to wash the floor. Does it have water inside of it?"*
Resident C: *"It better turns around because it cannot go any further. It doesn't really know what way it wants to go.* (short pause) *It could be that it figured it out now."*
(Sanne moves around and drives closer to resident D who is talking to the staff member)
Staff: *"What do you think about that thing?"* - Resident D: *"I don't really know."*
Staff: *"It's supposed to wash the floor.*
Resident D: *"It's supposed to wash the floor? Ah, ok."*
Staff: *"Yes."* - Resident D: *"That's good."*
Resident C: *"Does it only washes or does it polish?"*
Staff: *"I don't think so, that could be smart though."*
(conversation continues for around 2 minutes)
Resident C: *"It can't bite so that's something. It's just walking around and saying hello - it's pretty fun."*

In this dialogue, Residents C and D immediately accept the cleaning function, without any critical comments. C, who is still fairly fit intellectually, enquires about how Sanne achieves its cleaning function and what exactly the robot can do (but does not question its abilities). At the end, resident C appears to refer to the cat/non-cat nature of Sanne, who, unlike a real cat, cannot bite, but is saying hello to people.

In vignette 4, resident E sits at a table with a caregiver while Sanne approaches. E was later described to us by staff as 'very observant', even if his talk would sometimes be incoherent. After a while, resident F enters the conversation.

Vignette 4: Sanne moves towards resident E.
Staff: *"It's a floor washer. What do you think about it?"*
Resident E: *"It looks funny!"* Staff: *"Does it look funny? It's good that it doesn't look ugly."*
Resident E in friendly voice: *"If you have to wash the floor you have to stay up all night."*
(Resident F walks towards them, stops at the table and enters the conversation)
Resident F: *"What's this?"* Staff: *"Watch out for the Baboon there"*
Resident F (laughing): *"Oh, hey you! Go home with me. Looks good what she's doing!"*
Resident E: *"It's supposed to wash the floor!"*

The statement of the staff member towards resident F has a humorous tone, as the resident came to the table very cheerfully, and 'baboon' is used in Danish for funny objects or creatures. Resident E readily accepts Sanne when introduced as a floor washer, and soon thereafter, introduces Sanne in this function to F. Another situation where Sanne is introduced as *"It's a toy that's supposed to wash the floor (..)."* leads to an euphoric reaction of the resident, touching Sanne and saying *"That's fantastic!"*.

Thus, the residents accept Sanne being introduced as a cleaning robot in the shape of a cat and are interested in its functionality. If the robot is introduced as a cat, residents are more likely to object and to question its purpose and functioning. This confirms findings from the literature [16], that elderly people dislike being deceived about the nature of a robot, and perceive this as inauthentic. Interestingly here, when introduced as a functional device that happens to have the shape of a cat, this does not raise resistance, and as we will see, residents readily engage in make-believe interaction as if Sanne were a real cat.

5.4 Make-Believe Interaction - Encountering Sanne both as Cat and Machine

The video recordings revealed that most residents that interacted with Sanne clearly understood that she is a machine (and not a living animal), but repeatedly interacted with her as if she were alive and used behavior scripts associated with the role of a house cat. From seven instances where Sanne had been introduced as a floor cleaning device, residents twice then addressed the robot as if speaking to an animal. This could be seen in vignette 4 above, with E's utterance *"If you have to wash the floor you have to stay up all night"*, spoken in a friendly voice as if to an animal. In vignette 5 below, resident G also talks directly with Sanne (this situation is further described in subsection 5.6). Both G and E talk to Sanne like at an animal, discernible also from the tone of voice used. G sits at a table in the common room with two other residents, a staff member and a researcher. She reads a magazine as Sanne drives into the room at regular speed.

> Vignette 5: The resident notices Sanne and looks up from her magazine. She turns a little towards her and shifts her gaze between Sanne and the researcher.
> Staff: *"It's a thing that washes the floor."*
> Resident G: *"Yes. Is it true? Can you do that?"* (looking at Sanne)

Residents alternated between make-believe (Sanne as cat) and treating or referring to the robot as machine. From five that touched Sanne (table 1), three first caressed her, and then scratched, lifted her up, or even knocked on Sanne's head. Vignette 6 demonstrates this mix (see fig. 10). According to staff members, resident H, who was 'visited' by Sanne in her room, cuddles and talks to the stuffed toys in the home and refers to them as 'children.'

> Vignette 6 (part 1): Resident H sits in her armchair and talks with staff members. Sanne approaches her.
> H: *"Are you coming hopping there, little guy?"* She bends down and touches Sanne gently at the head.
> She grabs Sanne's ear and shifts the head a little.
> Knocking on Sanne's head between the ears, she says laughing: *"You can't really feel that, can you?"*
> Sanne drives a bit backward
> H waves at her: *"Yeah, that's fine, just leave, go ahead."* in a friendly tone.
> Sanne moves closer again and wiggles to get her attention back. (short pause)
> H: *"Yeah, I also think you are cute. Do you want me to scratch you behind your ears?"*
> H scratches Sanne behind the ears, with the fingernails.
> She then bends over to reach Sanne and knocks under her right ear: *"Is anybody home?"*
> She giggles: *"Yes you are a crazy one"* The staff member explains: *"She is supposed to wash the floor."*
> (... further talk between staff and resident, pause, Sanne then turns around and leaves the room ...)
>
> (part 2) Three minutes later, resident H now sits on a sofa in the common room, wrapped in a blanket and lures Sanne with clicking noises once she approaches.
> A staff member stands close-by.
> H: *"Hello little dog."*
> H reaches out a hand, bends over and softly pets Sanne's nose: *"Yeah that's nice."*
> She changes from stroking with the back of her hand to more intense touching of head and ears.
> H: *"Uh it's hard on top."* Staff: *"Doesn't it look nice?"*
> H: *"It looks really cute and could easily be a regular one. But it can't say something."*
> H observes Sanne, giggles, reaches out and knocks between Sannes ears.
> H (with a sad face and pitying tone of voice): *"I feel bad for you that you have to be inside a shell."*
> H continues to touch Sanne for another minute until Sanne drives away.

The way Sanne is initially greeted and touched by H resembles that of encountering a friendly pet. There are no signs of being scared or confused. H alternates in utterances and actions between pretend-play that Sanne is a cat, and acknowledging and exploring her machine-nature. At the start, she grabs Sanne's ear and pulls the robot, in a way one would not treat an animal. She quickly goes from petting and touching the head to knocking, and says *"You can't really feel that, can you?"*, which underlines that she knows Sanne is a machine. Then, she treats Sanne like a pet again, asking if she wants to be scratched behind the ear. In part 2, H continues to softly pet and talk to Sanne as if she were a cat, but also explores the material, comments on its hardness, and that *"it (...) could easily be a regular one. But it can't say something"*, telling the staff member that she is well aware of the machine-nature. She then expresses pity for the robot, who has *"to be inside a shell"*. We can't tell whether she really is sad or play-acts, as with a doll. H clearly knows that Sanne is not alive, that some sort of mechanical agent is inside, but nevertheless interacts with her as a cat.

Interestingly, in part 2, H greeted Sanne with *"hello little dog!"*. A few other residents also, in talking to or about Sanne, referred to other animals like dogs or baboons. This may indicate that residents associate Sanne into a larger category of animal toys. Sometimes (e.g. with the "baboon" reference) such mis-categorisations appeared to be jokes about this clearly unrealistic and cartoonish cat.

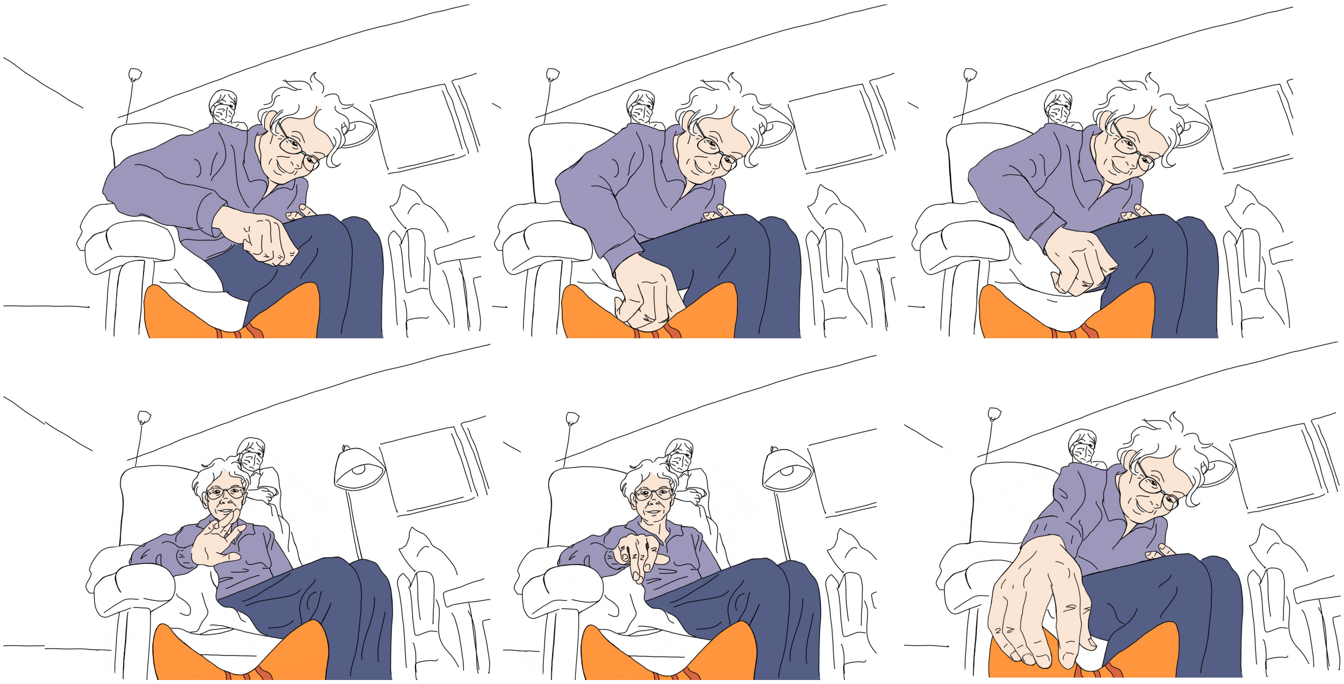

Figure 10: (top row): Resident H knocks Sanne on the head: *"You can't really feel that, can you?"*, waves her goodbye and later pets her ear after Sanne has navigated back to her (lower row, middle and right) (vignette 6, earlier section of part 1)

In the following vignette, we can detect some hesitation from another resident, who first appears unsure about whether to give in to pretend play and to be seen doing this, then engages with Sanne, and finally makes a joke, maybe in an attempt to detach himself again from this make-believe situation.

> Vignette 7: Resident J sits alone at a table and notices Sanne from far away. His head rests on his hand (leaned on the chair's armrest); he observes Sanne approaching and wiggling. J constantly looks through the room and then back at Sanne. He stretches out his hand to Sanne, but moves it back to his chin when somebody walks by, and nervously laughs into the person's direction.
> J waits until another resident has walked past, then reaches out and makes luring gestures towards Sanne, smiles and generates clicking sounds and nods into her direction.
> Sanne approaches and J touches Sanne twice with the back of the hand, mumbling something.
> J leans back, smiles, observes Sanne, but also scans the room.
> A staff member comes closer, J turns to her, smiles and points at Sanne
> Staff: *"It's cute, right?"* Resident J: *"Yes - I will take it home with me!"*
> J continues to touch Sanne, scratches her between the ears, observes the blinking camera behind Sanne's ears and nods into her direction.
> J (laughing): *"We have to watch out if a tooth comes out of it."* (resident and staff laugh)

The resident initially appears to feel insecure and observed (holds his hand at the mouth/chin). He constantly looks through the room, and stops initial interaction with Sanne when somebody walks by. By saying *"It's cute, right?"* the staff member assures it is alright to interact with Sanne. The resident then pets Sanne with the back of the hand and inspects the camera, alternating exploration of the technology with 'as-if' interaction. His joking statement at the staff member *"We have to watch out if a tooth comes out"* labels this interaction as not serious; maybe he is concerned about being seen as acting childish (cf. [54]). As he touches Sanne a lot, he is in fact not afraid of a tooth.

Our analysis reveals that a cleaning robot in the shape of a cat can work in the context of people with dementia. The vignettes illustrate that even if Sanne was introduced as a floor washer, residents related to her as a cat-character. They petted her, nodded at her as if she would react, and talked to her in a tone of voice like to an animal. But they appeared to not mistake her for a real animal. Almost all residents that touched the robot shifted between petting (a cat) to a material check, knocking, scratching, or lifting the robot, investigating its material and how it might function. Residents' awareness that Sanne is machine-like is also evident from many comments about Sanne or directly addressed to her, including statements like 'you can't really feel this' that simultaneously address her as a character and acknowledge her machine-nature. We did not see any indication of residents being confused by Sanne, only some evidence that some hesitated to be seen engaging in pretend play. Overall, we find that residents were capable of encountering Sanne simultaneously as a machine and a cat character.

5.5 Providing a Talking Point

As became apparent in some vignettes, Sanne also served as a talking point and opportunity for jokes. While staff usually engage residents in conversation, in our earlier ethnographic-style observations we had seen far less interaction in-between residents. Anything that can spark conversation thus can disrupt the monotony and foster human connection. In vignette 3, residents C and D discuss Sanne with a care worker, with C asking more complex questions and joking that Sanne cannot bite. In vignette 4, resident E explains to F, who enters the conversation, that Sanne is *"supposed to wash the floor"*. Another male resident, at some point walks past Sanne, stamps on the floor and says laughing: *"Oy, I shouldn't hit you."* in a performative way for all around to see and hear. Our study thus provides some evidence for the suggestion from Lazar's work with focus groups [44], that robotic pets could indirectly contribute to reducing loneliness, by providing a 'ticket to talk', something entertaining to watch, and thus being a social facilitator.

5.6 Relationship Over Time

Some of the residents saw Sanne more than once and reacted differently to her. Here, we detail such changes in behaviour in regards to how this indicates development of the relationship and growing familiarity. The following examples illustrate how quickly familiarity developed and the range of attitudes and relationships (or behaviors).

In vignette 2 (see section 5.3) Resident B saw Sanne the second time. The day before, she had been curious about the robot, lured it, whistling and stretching out her hand. Sanne then was introduced to her (as floor washer). She even tried to show the robot to another resident who sits in a wheelchair and has problems to see the floor. B stood up, went over to this person, pointed at Sanne and talked about her, trying to direct their gaze towards Sanne, but did not succeed. On the second day (vignette 2), when Sanne was introduced as a cat (not as floor cleaner), she reacted averse, said the robot is nothing new and that she saw it already. She thus clearly remembered Sanne, despite of dementia.

Our video data indicates a developing of familiarity for Resident J (vignette 7 in section 5.4). On the first day, he observed Sanne intently until she was in front of him, and fixated his gaze on her. He then interacted with Sanne, petted her and made jokes about her. As noted, he appeared a bit unsure how to react and about being seen interacting in pretend-play. This is very different on the next day, when he initially does not pay attention to Sanne. J sits alone in a corner of the room and looks out of the window. Behind him is a low room divider panel with people walking past.

> Vignette 8: The robot stops and wiggles a while; eventually J looks at Sanne. He scratches his head, raises his eyebrows, and crosses his hands on his lap (his body language suggests that he forces himself to not interact with the robot).
> After observing Sanne for a while, he nods in her direction, giving her a signal to come closer and touches her once she approaches.
> He examines the camera, knocks Sanne's head, and covers the blinking light of the camera with his finger (focusing on examining the technology and material - different from the previous day, when he stroked the robot). During this entire time, his gaze keeps scanning the room, and then goes back to Sanne.
> Finally, when Sanne drives backwards, he waves goodbye.
> After a while, Sanne drives back to him, but he is in a conversation with staff and only looks at her briefly. He does not look up when she wiggles at his feet.

It is evident that resident J remembers Sanne, but is mostly curious about the robot's technical aspects, and does not intend to interact much with her cat character - Sanne recedes into the background while he focuses on other activities (it remains an open question whether he would engage with her if there were no onlookers). While resident J does not engage in lengthy pretend-play with Sanne, he still acknowledges her presence and waves at her - or ignores her when busy talking. This vignette highlights that the robot behaviour needs to tread a fine line between aiming to attract attention and not being obtrusive or too persistent.

Resident H had been very deeply engaged with Sanne, petting her. Staff told us that she had been a kindergarden manager and was very affectionate with the dolls in the home, in a very similar way as with Sanne. Her interaction with Sanne (vignette 6 in section 5.4) had been stopped when Sanne moved out of the room, and the resident was assisted by one staff member to the lounge room. This staff member reported to us that H then asked *"If I need to go to the lounge room, what happens to the pet?"*. This shows that she very quickly established attachment to Sanne after this first encounter. Shortly after (vignette 6, part 2), she expresses compassion with the robot by saying *"I feel bad for you that you have to be inside a shell"*.

Vignette 9 (extension of 5) shows an interesting sequence where a less straight-forward relationship evolves. It is the second time resident G sees Sanne. On the previous day, she had lunch while Sanne drove past. The resident was asked if she can see it and was explained it is a floorwasher. She continued eating and just answered *"Yes."* Now, she sits at a table with a staff member and another resident and reads a magazine. Sanne drives into the common room.

> Vignette 9 (part 1): Sanne waits in front of the resident, wiggles and G looks up and at her.
> Staff: *"It's a thing that washes the floor."* G: *" Yes. Is it true? Can you do that?"* (looking at the robot)
> G: *"Goodbye. Goodbye."*
> Staff: *"Does it have to go home?"* G: *"You have to go home."* (Sanne drives a little backwards)
> G: *"That way, that's right. That's good."*
> (Sanne drives back and forth for a minute, following the residents' instructions)
> (Sanne approaches again, wiggles, G and staff talk about her, Sanne comes closer)
> G (raising her voice): *"Hello. Are you washing the floors*

back again? Do you remember that? You have to go back. Yeah, that's good."
Staff: *"Are you good at it? Is it doing what you are saying?"*
G: *"You are going back."* (Sanne drives a litte backwards) G: *"That was good."*

Resident G appears to remember Sanne and, again, readily accepts the floor-cleaning function as well as directly talking to the robot (addressing it as a character) *"Are you washing the floors again?"*. Unique to G's interactions is that she begins to command the robot: *"You have to go home"*, *"You have to go back"*, and praises it for obeying. This reminds of someone training a dog or (trying with) a cat. G appears to get satisfaction from the robot following her commands. In what follows, one can see how G's dementia effects her understanding of the situation and her memory.

Vignette 9 (part 2): 2 minutes later, Sanne approaches G again. G raises a finger.
G (in low voice): *"Go over there. There, over there."* (G looks a little angry. Sanne wiggles on the spot)
G: *"Will you not listen to what I'm saying. You need to do what I'm saying. – Now!"*
Staff: *"Do you want it to go away?* - (pause) - *It's just washing the floor."*
(The staff repeats the explanation three times while G apparently cannot process this; G reacts puzzled, with a questioning look on her face ...)
G (with a deep voice): *"Someone is washing on you. That can't be right. Go away now."*
G: *"Yeah you have to listen to what I say."* (Sanne drives slowly backwards)
G: *"Yeah that's good. That's how it should be."* (Sanne drives away a little quicker)
Staff: *"Did it do what you said?"* G (in higher voice): *"Yeah!"* (looks relaxed)

G here becomes very authoritative in her commandeering (*"Now"* with a raised finger). It appears G has forgotten about and cannot process or understand the staff's repeated explanations of Sanne's function as floor cleaner, and is confused. A staff member later explained that people at more severe stages of dementia 'can just focus at one thing at a time'. After part 1 of the vignette, another resident had approached and said something, which shifted G's attention away from Sanne. Yet, as long as the robot follows her instructions, she does not appear to be scared. Her behaviour reminds of how one would commandeer an animal, she thus reacts to Sanne's cat-character. When the robot obeys, she becomes more friendly in her tone of voice and facial expression. In her response to the staff's question, whether the robot did what she said, it almost sounds like she is proud that Sanne obeys. Around 9 minutes later, G encounters the robot again, and now is friendly and relaxed. Here, Sanne returns, driving in G's direction.

Vignette 9 (part 3): G sees (or hears) Sanne from a distance, raises her head, looks up, smiles.
G lures Sanne with a whistling sound
G: *"Hello!"* Staff: *"Is it coming back?"*
G (high and friendly voice): *"Hello you, what's your name?"* Staff: *"It's going to live here. It's Sanne."*
G: *"Sanne! Go to Mama. Just gallop a little, friend!"*
(Sanne comes closer)
G: *"Yeah, that's fine. You have to come here!"* (Sanne drives backwards again)
G: *"No, not that way."*
(... some back and forth of the robot, conversation with care staff ...)
G (high voice): *"Go over there now. To little Mom. Come over here now, it must be now."* (Sanne drives away)
G: *"Now you must go. Move along now. Away with you. Go back. Yes, you have to go home."*

Compared to a few minutes before, G's mood changed significantly. G talks to Sanne in a friendly and sweet voice, refers to herself as 'Mama' and asks Sanne to come closer. She asks for her name and calls Sanne her 'friend'. Similar to before, she continues to commandeer her to 'come here', 'go over there', 'go back'. It appears as if she has forgotten about Sanne, since she does not respond to the question whether Sanne came back. We can only speculate whether to herself, she sees Sanne for the first time, or whether a sense of familiarity has been retained, given her friendly mood and interaction with Sanne.

Here it was important for G to experience control over the robot. Other vignettes show this in a more subtle way, e.g. in vignette 8 a male resident gives Sanne a nod to invite her to come closer, or people generally wanting to lure the robot and reacting happy if it then approaches. This confirms our design decision for the behavioural pattern of Sanne (attracting attention by wiggling on the spot, and approaching when this is achieved). Coghlan et al [16] found in their studies that older adults want a sense of control in their interactions with robots. Overall, for most residents who encountered Sanne several times, we can see growing familiarity, either to a closer and caring attitude, a more relaxed interaction, or to her becoming a background object that can be ignored if the resident chooses to.

6 DISCUSSION

Our study provides insights into the potential social role that assistive robots may have within practical daily routines of institutional care work, and shows how a playful approach can lead to the creation of robots that are perceived as funny and non-threatening by people with dementia. Most importantly, the responses to Sanne that we were able to observe were in general neutral or positive, with only one negative reaction (of a resident who hates animals). None of the residents showed any forms of distress, fear, or anxiety, which according to the care home staff were evident during trials with a Roomba. Further, the observed interactions of residents with Sanne had an emotional and social richness comparable to when they were interacting with staff, the clown or stuffed animals. We discuss how we contribute to an understanding of the social role of assistive robots on the background of Latour and Barad's theoretical framing. We also return to the implication of our design approach, that residents can choose whether to engage with the social role of the robot or to only acknowledge its utilitarian function, and what this means for dignity in care. We further discuss how care practice has playful aspects and how play can support residents affected by dementia to engage in a lighthearted process of sense making of a new technology.

6.1 The Social Dimension of Daily Practice and Assistive Functional Robots

Currently, robots tend to be either social or utilitarian (if companion robots combine practical and social functions then they address primary needs of users, where they will directly interact with them). A floor cleaning robot requires no interaction from residents, and would only be handled by care staff. Although floor cleaning in theory thus would not impact residents, the failed deployment of a Roomba shows this is not the case. The Roomba story reveals the central role of social aspects in human practice, which are context dependent. It illustrates Barad and Latour's theories [4, 42], that the "social" cannot be isolated from human practice and the role of tools in these; the social always determines what tools fit the practice. A key finding of our study was that utilitarian robots that embody a social role can be more easily accepted in the context of care homes, even if the robot takes care of trivial tasks without a social component. With this, we dissolve the dichotomic distinction between utilitarian assistive robots and social robots.

6.1.1 Making Social Agency Visible Through Design. A key point of departure, that inspired our design and was confirmed by our observations, is that the presence of (partly) autonomous technologies in human space and people's perception of these, can elicit a spectrum of emotional responses, from rejection and acceptance, to distress and enthusiasm. Novel functionally assistive robots to be introduced in care homes and sharing space with residents, thus have to be approached as social actors, taking into account the residents' cognitive and emotional needs and reactions. Different from studies on Roomba [28, 69] that found social agency for a non-social robot design, our design approach intentionally aimed at the ascription of social agency onto our robot Sanne, and invited playfulness. This design strategy was confirmed by reactions in our study, which spanned from playful reactions and approaches, laughs, to ironic smirks and jokes. This also avoided strong negative reactions, with Sanne being ignored as the 'worst' outcome. Thus, our study provides insights on how acknowledging the social in the design of assistive robots can support a more creative exploration of role, appearance and functionalities of such robots, contributing to the perspective of Lee and Riek [45] who advocate to more widely explore the role of robots for care homes in collaboration with residents and staff.

6.1.2 Sanne - Cat, Dog, or Baboon? It was interesting that names of other animals, such as 'baboon' or 'dog', were used by a staff member and a resident, to talk to or about Sanne. There is thus a consistent framing in terms of zoomorphism, where 'cat' can be replaced by another animal. In the case of the staff member, there was clear intent in mocking Sanne to elicit laughs from residents, pointing out that it mimics a very cartoonish cat, and could be just about any animal. The woman who called Sanne a dog, was cuddling her while commenting on her hard shell, and possibly trying to make sense of it while at the same time playing with a pet-toy.

6.2 Inviting Pretend-Play - The Cat-Non-Cat

Lazar et al [44] argue that a make-believe stance in interaction with robots dissolves problems of in-authenticity, while others argue that deceiving about the real nature of a robot is unethical [9, 61, 62]. We found that care staff at our study site was rather pragmatic in accepting toy-like robots, based on the fact that for people with dementia, dolls and similar existing objects can have a therapeutic function. Our study revealed that residents readily accepted Sanne when introduced as a cleaning robot, and accepted its cat-like looks and behaviour, and were neither scared nor confused. They quickly engaged in make-believe interaction with Sanne as a cat, while acknowledging her mechanical nature at the same time, even pitying her for 'being inside a hard shell'.

6.2.1 Giving Choice to Engage Playfully - or Not To. When Sanne is introduced as a cat, residents resist 'it is a fake cat' and are critical - this is in line with research showing that elderly people feel being deceived about the nature of robots is condescending, infantilizing, and patronizing [16] and not wanting to be seen as acting childish [54]. Interestingly, if Sanne was introduced as a floor cleaner/washer, residents readily accepted this, did not once question why a floor washer looks like a cat-toy, enquired about technical details, and often readily succumbed to acting as-if luring and petting a cat. Our observations of how residents shift between talking to Sanne as if she were a pet and acknowledging her machine-nature seconds later, confirm findings by Lazar et. al. [44] that elderly people find a make-believe situation acceptable if this relies on people voluntarily and self-aware giving in to fiction, and show that this also holds for many residents affected by dementia.

A key point here is that introducing Sanne as floor cleaner gives residents agency in reacting either to the utilitarian purpose of the robot or to its character, thereby retaining their autonomy and dignity. It leaves it up to individual residents to decide whether and how to react to Sanne. As we saw, some residents simply chose to largely ignore Sanne (albeit acknowledging its presence). Coghlan et al [16] note that preferences amongst elderly people are diverse, with some enjoying a dedicated companion robot and others not wanting to engage in 'inauthentic' and childish interactions. But for a care home, providing a dedicated social robot for individual residents would be inefficient and costly. Our design approach, combining a utilitarian function with a social role, has the advantage of accommodating the majority of residents, and at the same time giving the option to simply ignore the robot. The robot also provides a talking point and thereby can contribute to increasing social interactions amongst residents and with staff.

Nevertheless, as we saw in the example of resident G (vignette 9), who commandeered the robot around and did not understand explanations about its function, such a robot, when cleaning floors, should be easily readable, so residents with dementia know when it is busy and can associate it with its task. How to indicate different modes (friendly cat-toy versus busy cleaning or otherwise not approachable) will be a topic for further research for us. Vignette 9 also demonstrated that it is important for the robot to understand simple instructions (go away, come here) or gestures, since, as Coghlan et al [16] also note, older adults want a sense of control in their interactions with robots.

To enable residents to ignore the robot, it should not be pushy for attention. Sanne should thus limit her attempts at approaching a resident, so as to not be annoying for those who are busy or prefer to ignore her, are not interested, or find the robot too childish. This was easy in our case since Sanne was controlled via WoZ, but will be more difficult for an autonomous robot. Here, apart from technically more complex solutions that detect tone of voice, keywords and gestures (e.g. luring), a simple approach could consist of care staff noting after a couple of days who likes to engage with the robot and then to pre-program who should not be approached, combined with e.g. face recognition. This would in particular be useful so as to enable Sanne to avoid those residents that react generally negatively.

6.3 Creating playful assistive robots – implications for design and sense making

Current work on care robotics also underlines the importance of playful values and functionalities, which, however, are often not fully articulated. Pet-robots like Paro or NeCoro invite play, and social robots like Pepper can support playful activities. Moreover, when assistive robots are introduced as potential butlers or companions [13, 19], these terms suggest that one might relate to such robots 'as if' they were assistants. This 'as if' condition can lead to 'what if' questions - a pre-condition for pretend play in the terms of Bateson [6], and elicit a playful mood [66].

Our analysis of care practice at the care homes and our design approach leverage play theory [38, 66], in understanding the social interactions observed at the care home as well as in the design of our robot's role. We were inspired by the playfulness that we found in various practices at the care home, in the attitude of staff towards residents, and their use of digital and analogue tools and toys. We argue that play is at the core of the interactions and negotiation of meaning embodied in practice but also in the design of many tools for care homes residents, including robots. Taking this perspective enabled us to to challenge and re-interpret the values typically associated to tasks like cleaning the floor, and to reconfigure these practices (and objects) within a playful storyworld in which the physical space of the care home, and residents can participate.

6.3.1 Sense-making through Pretend-Play and Exploration. The negotiation of meaning (sense-making) between residents, caregivers and Sanne took place through forms of pretend-play. In reacting to Sanne's appearance as a plastic cat, which suggested to approach her as-if she was a cat, the residents cuddled, petted, stroked and scratched Sanne's ears, but also knocked on her head, felt and inspected the material qualities of her body. Many of these actions can be interpreted as a form of sense making, as the residents used their hands, played with and explored the surface structure as well as talked to her, to make sense of Sanne as an artefact, as well as a social actor [42]. With this, residents also tested how Sanne reacted to their actions. Through this, they appeared to be constructing an understanding of Sanne as an autonomous agent and reflected this understanding in conversations with other residents or the staff.

6.3.2 Character Design Can Leverage Familiarity. Judging from residents' reactions, our design approach, which built on knowledge about character design methodology, was successful. Many residents responded to Sanne spontaneously, on their own initiative, as it occurs between players and the characters displayed in a digital game [41, 67]. They interacted with Sanne in make-believe interaction, as-if with a cat, luring, stroking and talking to her, and acted as if they decided to play along. Petting or scratching the ears and the top of the head is a typical action with a real cat or stuffed animal toy, signaling a natural interaction [41], or following known interaction scripts with such an entity. It can be argued that the design of Sanne leverages the ability of people affected by dementia to interact in a natural way with familiar looking objects [11, 33]. Our playful design strategy further successfully conveyed a silly and laid back mood, which is at the core of playful values [66]. Constructing Sanne as a pet-toy enabled us to communicate that Sanne should play a non-threatening role, whose presence is to elicit laughs, calmness, irony, or can simply be ignored. This also contributes to downplay her technological nature, which could elicit concern in residents and staff.

Our study thus shows an alternative to realism for zoomorphic robots. It illustrates how cartoonish design, that exploits mechanisms used in character design for video games or animation, can help to make technological devices non-threatening, while simultaneously conveying the artificial, mechanic nature of the robot and inviting playful reactions. It further provides an example for how a playful approach can help to integrate utilitarian robots into the social structure of a care home, which might even be enjoyed by residents, turning them from a nuisance into an amusing or at least tolerable object.

7 CONCLUSION

We followed a playful design strategy for an assistive robot for a care home, informed by character design methodology and field observation. Key for our design strategy was to combine a utilitarian robot (in this case a floor cleaner) with a social role, based on the understanding that any entity that shares space with people is a social actor, and thus should be designed as such. A proof-of-concept prototype was evaluated through an in-situ study in our partner care home, deploying the robotic prototype controlled by a wizard over several days for short times, so that residents could encounter it repeatedly. The interactions were recorded on video and sequentially analyzed.

We found that residents readily accepted Sanne being introduced as a cleaning robot and spontaneously reacted to her as a cat-toy, but often objected to her being introduced as a cat. Residents clearly understood Sanne to be a machine-like entity, even if interacting with the robot as-if it were a cat, and often quickly alternated between referring to its status as machine and as cat-character, with almost no signs of confusion. The robot was perceived as funny and non-threatening, provided a talking point, but could be (and was) easily ignored by residents that wished so. It appeared to be important for residents to feel that they can command the robot and experience control over it. Furthermore we found that residents despite of their dementia quickly developed familiarity with the robot, with some treating it affectionately.

Our main contribution is providing an example for a new design strategy of creating a social (playful) role for a functional robot, and demonstrating through a user study that this approach is productive. Our study demonstrates that a playful approach to design, which elicits a playful mood marked by 'lightness' and openness through design features [38, 66] and informed by character design strategies [40, 41, 60, 68, 73], can enable care home residents to make sense of new technologies through forms of pretend role play. It also demonstrates that in the context of dementia care, providing the robot with a static face is sufficient, if the robot attracts attention in other ways. Most robot design guidelines have been derived in other contexts, emphasizing eye movement and other attractors of attention [5, 36, 75], whereas here, the cognitive and emotional processing characteristics of dementia need to be taken into account.

Our study shows how a playful conceptualisation of its social role can contribute to the ability of a utilitarian robot to fulfill its functional task in the context of care for people with dementia. This dual role had two effects. On the one hand, the social role contributed to making the machine non-threatening and being accepted into shared space. On the other hand, the robot's utilitarian function gave a legitimization for it being there, and - especially when being introduced as cleaning robot - provided choice and agency to residents whether to engage with it as a social robot or as a functional device, or to ignore.

A limitation of our study is that our prototype is not able to clean floors and we thus were not able to test it in 'cleaning mode' or to investigate how activating this mode would influence general reactions to the robot. Future work is to investigate movement patterns for our robot and to develop a version with a real vacuum cleaner or floor washer integrated, and to then run a longer test where the robot changes between 'cleaning mode' and 'friendly cat' mode. We plan to investigate how 'cleaning sounds' could be masked by cat/toy sounds, and whether cleaning noise still constitutes an issue when Sanne is a familiar entity, and aim to explore the integration of further cat-like behaviors.

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